THE RAILWAY REVIEW

No. 52 DECEMBER 26, 1896. XXXV.

STRAIGHTENING THE BALTIMORE & OHIO TRACK.—One of the worst places on the Baltimore & Ohio for curves has been between Tabb's station and Myer's Hole, a few miles west of Harper's Ferry. Recently, however, the company has appropriated $80,000 to straighten the track at this point. The present grade is 8 per cent, and the maximum curvature five degrees, with a number of reversions. A new line has been run with a grade of 10 ft. per mile and a maximum curvature of three degrees with long tangents. The contractors have already begun the work, but it will take several months yet to complete it. In grading, about 120,000 cubic yards of material will be removed and the arch culvert at Myer's Hole will have to be extended with iron pipe. The material to be removed consists of clay and limestone rock in pockets and small ridges.

THE GROWING USE OF GAS AND OIL ENGINES.—Gas and oil engines find a constantly widening field of usefulness. Among the latest applications are those to mine hoisting ing and mine haulage, and for both services designs have been put on the market which will probably help a good deal toward still further popularizing engines of this class. For hoisting work particularly and especially in the case of small mines where the hand windlass or the horse power machine wil. no longer give satisfaction, the gas or oil motor offers a number of advantages worth considering, among them the stereotyped, but none the less important, one of fuel convenience. The water supply question, also, is easily disposed of, since the same water—and a small quantity, too—can be satisfactorily used over and over again to cool the engine, while its quality needs no consideration so long as it will not badly corrode the iron. With the scarcity of even fairly good water, that is experienced in many mine localities, this feature of the gas or oil engine outfit will be specially appreciated.

LOCATION OF ELEVATORS ON RAILROAD RIGHT OF WAY.—The supreme court of the United States had before it recently the appeal of the Missouri Pacific Railway Co. from the decree of the supreme court of Nebraska directing the railroad company, at the request of the State Board of Transportation, to permit a party of farmers to erect a grain elevator on its right of way, and itself to construct a switch through it. The court reversed the decision of the state court, saying that it was not a question affecting rates of transportation, not an order compelling the railroad company to erect an elevator, nor a matter affecting equal rights to cross the property from the outside, but a demand that, simply for the convenience of the petitioners, they be permitted to build the elevator on the property of the railroad company, and this, the court were unanimously of opinion, was the taking of private property for private use without the due process of law, and therefore in violation of the plain terms of the constitution.

THE MECHANICAL STOKER.—It may certainly be said without fear of contradiction that the mechanical stoker has come to stay; that is to say, it has come to stay in large plants, but whether it will ever be able to compete with a really skilful fireman in small installations where one man is sufficient for the performance of all of the duties of engineer, fireman, greaser and coal passer, is open to doubt. The intelligence that places the shovelful of coal just where it is most needed and discriminates in the quality of the coal, the regulation of the air inlets according to the state of combustion, are little things that tell mightily when the element of wages has been laid aside. On the other hand, a large battery of boilers will probably never be fired as economically by hand as they will be by a high grade mechanical stoker, and where the steam consumption is even, the steadiness of the entrance of the coal upon the grates and the entire absence of heavy indrafts of cold air through the doors into the furnace, coupled to the saving of the wages of one or more firemen, places the mechanical stoker high in the grade of economical appliances.

MACHINE FOUNDATION.—I was somewhat astonished the other day to have an engineer tell me that nothing but a grouting of Portland cement was fit to be used for underbedding a machine after it had been leveled on its foundation by wedging up, remarks J. H. Allen in Dixie. Sulphur was asserted to be worthless. Now I had always pinned my faith to sulphur—well, it was "scissors" to the last. Then I went and looked at a heavy boring mill that I had "floated" on sulphur for ten years. It was as firm as a rock and as level as level could be. Now, I am wondering where sulphur could have made so bad a reputation, and have about come to the conclusion that it has been run too cold. Sulphur, to be used satisfactorily, must be perfectly liquified and hot enough to flow to the remotest crevice within the limits of the dam before it solidifies. and that means, when it is to be run in a quarter inch space between a cold stone and a cold base for a distance of seven or eight inches, that it must be pretty hot and that the ladle should be large enough to flood the whole space at one pouring, so that the setting may be even at all points, and when these precautions are taken there can be nothing said against its efficiency. Oh, yes, Portland cement grout is all right, too. In fact, neither cement nor sulphur can be used carelessly, and the man who is negligent with one is apt to blame the material rather than himself, and then take extra precautions to insure success with the other material.

THE GRAND TRUNK MANAGEMENT.—General Manager Hays, of the Grand Trunk Railway, recently said in connection with the reported tendency of the road under his management to employ fewer Canadians: "It must be remembered that there are employed on the lines in Canada between 16,000 and 18,000 men, and it is simply ridiculous to talk of substituting even a small proportion of foreigners in their stead, as it would be impossible to get that many good men who would want a change. I am very glad to say that you can find as many capable and efficient workers who are anxious to give good service on the line of this road as can be found on that of any road of an equal number of miles in the United States or elsewhere, and all that is expected of them is that they shall promptly, cheerfully and loyally carry out such instructions as they may receive from time to time from the officers of the company; when this is done they will find that as opportunities for promotion or advancement occur, they will receive every consideration from the management."

A CONVENIENT METRIC CONVERSION TABLE.—The following metric conversion table which has been compiled by Mr. C.W. Hunt of New York City, could be with advantage pasted by engineers in their note books. Mr. Hunt has had copies of this convenient table printed on a slip, with a gum back, and will no doubt furnish them on request:

Millimeters × .03937 = inches.
Millimeters ÷ 25.4 = inches.
Centimeters × .3937 = inches.
Centimeters ÷ 2.54 = inches.
Meters = 39.37 = inches. (Act of congress.)
Meters × 3.281 = feet.
Meters × 1.094 = yards.
Kilometers × .621 = miles.
Kilometers ÷ 1.6093 = miles.
Kilometers × 3280.7 = feet.
Square millimeters × .0155 = square inches.
Square millimeters ÷ 645.1 = square inches.
Square centimeters × .155 = square inches.
Square centimeters ÷ 6.451 = square inches.
Square meters × 10.764 = square feet.
Square kilometers × 247.1 = acres.
Hectares × 2.471 = acres.
Cubic centimeters ÷ 16.383 = cubic inches.
Cubic centimeters ÷ 3.69 = fluid drachmas (U. S. P.)
Cubic centimeters ÷ 29.57 = fluid ounce (U. S. P.)
Cubic meters × 35.315 = cubic feet.
Cubic meters × 1.308 = cubic yards.
Cubic meters × 264.2 = gallons (231. cu. in.)
Liters × 61.022 = cubic inches (Act of congress).
Liters × 33.84 = fluid ounces, (U. S. Phar.)
Liters × .2642 = gallons (231 cu. in.)
Liters ÷ 3.78 = gallons (231 cu. in.)
Liters ÷ 28.316 = cubic feet.
Hectoliters × 3.531 = cubic feet.
Hectoliters × 2.84 = bushels (2150.42 cu. in.)
Hectoliters × .131 = cubic yards.
Hectoliters ÷ 26.42 = gallons (231 cu. in.)
Grammes × 15.432 = grains. (Act of congress).
Grammes × 981 = dynes.
Grammes (water) ÷ 29.57 = fluid ounces.
Grammes ÷ 28.35 = ounces avoirdupois.
Grammes per cu. cent. ÷ 27.7 = lbs. per cu. in.
Joule × .7373 = foot pounds.
Kilograms × 2.2046 = pounds.
Kilograms × 35.3 = ounces advoirdupois.
Kilograms ÷ 1102.3 = tons (2.000 lbs.)
Kilograms per sq. cent. × 14.223 = lbs. per sq. in.
Kilogrammeters × 7.233 = foot pounds.
Kilograms per meter × .672 = pounds per sq. ft.
Kilograms per cubic meter × .026 = pounds per cu. ft.
Kilograms per cheval vapeur × 2.235 = lbs. per h. p.
Kili-watts × 1.34 = horse power.
Watts ÷ 746 = horse power.
Watts ÷ .7373 = foot pounds per second.
Calorie × 3.968 = B. T. U.
Cheval vapeur × .9863 = horse power.
(Centigrade × 1.8) + 32 = deg. Fahrenheit.
Francs × .193 = dollars.
Gravity, Paris = 980.94 cent. per second.

EYESIGHT OF IRONWORKERS.—In the mining and foundry district of Bochum, Prussia, Dr. Nieden reports having treated during the years 1885-94, 5,443 patients engaged in such occupations, of whom more than 68 per cent were cases of injury to the eye in their calling—iron and foundry workers showing a large predominance in this respect over miners. Of 3,723 iron and foundry workers treated for eye injuries, 2,805 were for the left eye and only 1,639 for the right, or a relative proportion of fifty-six to forty-four; and as a similar proportion held good in each separate year, the conclusion arrived at is that in such work the danger to the left eye is really greater than that to the right. Even more marked, in fact, was the proportion in respect to the severe cases, the left eye being quite lost in 17 cases, the right eye in seven. It is urged, therefore, that in ironworkers the loss of the right eye should be calculated as the more serious, inasmuch as the individual then runs a greater risk of injuring the remaining eye than when he has lost the left.

AN ENGLISH VIEW OF MECHANICAL PROGRESS IN THE UNITED STATES.—It is remarkable that while Great Britain led the van in the introduction of steam locomotion, she has lagged in the rear as regards electric and other mechanical traction. This arose, in the first instance from mistaken legislation, which strangled electrical enterprise, which is still hampered by the reluctance of public authorities to permit the introduction of the necessary poles and wires into towns. At the date of the latest published returns there were at work in the United States no less than 12,133 miles of electric, in addition to 599 miles of cable, tramway. Hardly a large village but has its installation, and vast have been the advantages derived from these facilities. In Brooklyn one company alone owns and works 260 miles of overhead trolley lines. With the exception of some small tramways at Portrush, Brighton, Blackpool, South Staffordshire, Hartlepool, etc., the only examples in this country of serious attempts to apply electro-motive force to the carriage of passengers are the City & South London Railway and the Liverpool Overhead Railway, the latter being the latest constructed and having, therefore, benefitted by the experience gained upon the London line. In connection with electric traction, it is very important to reduce, if possible, the initial force required for starting from rest. Whether this will be best attained by the improvement of bearings and their better lubrication, or by the storage, for starting purposes, of a portion at least of the force absorbed by the brakes, remains to be seen; but it is a fruitful field for research and experiment. In the United States there is a very general and rapid displacement of the cable tramways by the overhead wire electric system. In addition to the application of electricity for illuminating purposes, and for the driving of tram cars and railways, it has also been applied successfully to the driving of machinery, cranes, lifts, tools, pumps, etc., in large factories and works. This has proved of the greatest convenience, abolishing as it does the shafting of factories, and applying to each machine the necessary power by its own separate motor; the economy resulting from this can hardly be overestimated. It is also successfully employed in the refining of copper, and in the manufacture of phosphorus, aluminum, and other metals, which, before its application, were beyond the reach of commercial application. The extent of its development for chemical purposes in the future no can forsee. Electric headlights are being adopted for locomotives in the United Stated. The use of compressed air and compressed gas for tractive purposes is at present in an experimental stage in this country. The latter is claimed to be the cheapest for tramway purposes, the figures given being—single horse cars, 5¾ d.; electric cars with overhead wires, 4¼d.; gas cars, 3¼d. Combination steam and electric locomotives, gasoline, compressed air, and hot water motors are all being tried in the United States, but definite results are not yet published. The first electric locomotive practically applied to hauling heavy trains was put into service on the Baltimore & Ohio Railway in 1895 to conduct the traffic through the Belt Line tunnel. It is stated that, not only was the guaranteed speed of 30 miles per hour attained, but with the locomotive running light, it reached double that speed. The actual working expense of this locomotive is stated to be about the same as for an ordinary goods locomotive, viz: 23 cents per engine mile.

A PACIFIC COAST VIEW OF THE INDEBTEDNESS OF THE TRANSCONTINENTAL ROADS.—Both the president and the secretary of the interior give a clear statement of the Union and Central Pacific's indebtedness to the government, and indicate with more or less lucidity what will happen after the first of January next if congress does not meanwhile take action in the premises. As the law at present stands the executive power must be exercised after the date named, to foreclose the government's mortgages. But that is something easier said than done, and if done would mean paralysis to pretty nearly every interest on this coast. The government cannot take possession of the Pacific railroads because the first mortgage holders have a prior claim to them. That prior indebtedness must be first extinguished before the government can begin to enter into possession. We do not think there is any sincere desire in any quarter to burden the country with any further responsibilities in regard to these roads. The general purpose rather is to get out of the whole business with as little loss as possible. The secretary of the interior is so anxious to have the government done with the matter that he recommends the immediate sale of the country's interest interest in the roads for a lump sum in cash. That course naturally follows upon foreclosure proceedings, but it may very safely be taken for granted that the "lump sum" the government would receive would amount to no lump at all. Nobody is going to buy a second lien when the road could be duplicated for the amount of the first. Nor is anybody going to invest in a road without terminals, feeders or entrance to this city. Inevitably the government's lien would go for a song. That might suit the wreckers, but most assuredly would not benefit the Pacific coast or the taxpayers of the country generally. If nothing better could be done the case would be vastly different. The present managers of the roads make an offer and back it with the guarantee of further security to repay to the government every dollar, principal and interest, that they owe if given reasonable time. No other roads in the country have been called upon to pay their first cost within the first quarter of a century of their completion. Why should these Pacific roads, built at the costly time they were, and having been of incalculable benefit to the government and to the country, be made the exception to the rule? Besides, if it were true that the managers of the road were making unduly favorable terms with the government, the advantage would inure to the traffic with this coast. The less the road has to pay the less it will have to collect from its patrons. It is insensate folly for California to urge the national creditor to extort the uttermost farthing from the managers of the road, because in the end California will have to pay that farthing. The proposed refunding bill is the only existing proposition that bears argument. Its enemies have been challenged in vain to submit a better scheme.—]San Francisco News-letter.

## EIGHT WHEEL EXPRESS LOCOMOTIVES NORTH-EASTERN RY., ENGLAND.

The North-Eastern Ry., of England, has recently built and put into service two large eight-wheel express locomotives which were designed by Mr. Wilson Worsdell, locomotive carriage and wagon superintendent of that road, for the fast and heavy passenger service on the East Coast route, which is worked between York and Edinburgh by the North-Eastern Ry. locomotives. These locomotives are the largest built by Mr. Worsdell and are also given credit for being the largest and most powerful locomotives in England. This design embodies large proportions and the bearing surfaces are made as large as possible with a view of getting the maximum mileages between shoppings for repairs. The engines are comparatively light, weighing but 101,600 pounds, and they are reported to ride unusually well. Up to the present time the heaviest load hauled by one of these engines in regular service was 284 tons exclusive of the engine and tender, the maximum speed attained being 50 miles per hour with this load. They have taken smaller loads at greater speeds, but no attempts have been made to ascertain the maximum capacity of the locomotives either in speed or hauling power. A noteworthy advance exhibited by these engines over the prevailing English practice is in regard to the provision of a cab which bears a close resemblance to American practice. The cab is provided with a clerestory roof with ventilators, and the appearance of this housing for the engine man is sufficient to attract considerable attention in England, to the advantages of protecting locomotive crews.

The cylinders of the engine are 20 x 26 in. and the driving wheels are 91¼ in. in diameter, which are the largest now in use in England. The driving wheel centers are 9 ft. 6 in. apart. The truck wheels are 43¾ in. in diameter, the wheel base of the truck being 6 ft. 6 in. The boiler seems small compared with the prevailing practice in this country, it being but 4 ft. 4 in. in diameter. The fire-box is exceedingly long for an English design. the length being 7 ft.; and the fire-box has 130 sq. ft. of heating surface, which is believed to be the largest of any passenger locomotive in England. The valve motion is of the Stevenson type, and the valves are placed upon the tops of the cylinders and are worked by means of a rocking shaft; the piston rods are prolonged to the front cylinder heads in order to steady the pistons. The tender is fitted with a water scoop, as many of the trains run through from New Castle to Edinburgh and in the opposite direction, a distance of 124½ miles, without stopping. The accompanying illustration and the information pertaining to these locomotives were taken from the Railway Engineer. For convenience in comparing this with American designs, the following table is presented:

CYLINDERS.

| | |
|---|---|
| Diameter | 1 ft. 8 in |
| Stroke | 2 ft. 2 in |
| Length of ports | 1 ft. 3 in |
| Width of steam ports | 2 in |
| Width of exhaust ports | 4 in |
| Lead of slide valve | ⅛ in |
| Lap of valve | 1 3-16 in |
| Maximum travel of valve | 4⅝ in |
| Diameter of piston rod | 3¼ in |
| Length of slide block | 1 ft. 3 in |
| Length of connecting rod between centers | 6 ft. 8 in |

WHEELS AND AXLES.

| | |
|---|---|
| Diameter of driving wheels | 7 ft. 7¼ in |
| Diameter of truck wheels | 3 ft. 7¼ in |
| Thickness of all tires on tread | 3 in |
| Width of all tires on tread | 5½ in |
| Length, center of truck to center of driving wheel | 11 ft |
| Length, center of truck wheels | 6 ft. 6 in |

CRANK AXLE (STEEL).

| | |
|---|---|
| Diameter of wheel seat | 9 in |
| Diameter of bearings | 8 in |
| Diameter at center | 7¾ in |
| Length between centers of bearings | 3 ft. 10 in |
| Length of wheel seat | 7 9-16 in |
| Length of bearings | 9 in |

TRAILING AXLES (STEEL).

| | |
|---|---|
| Diameter of wheel seat | 9 in |
| Diameter of bearings | 8 in |
| Diameter at center | 7¾ in |
| Length of wheel seat | 7 9-16 in |
| Length of bearings | 9 in |
| Length between centers of bearings | 3 ft. 10 in |

TRUCK AXLE (STEEL).

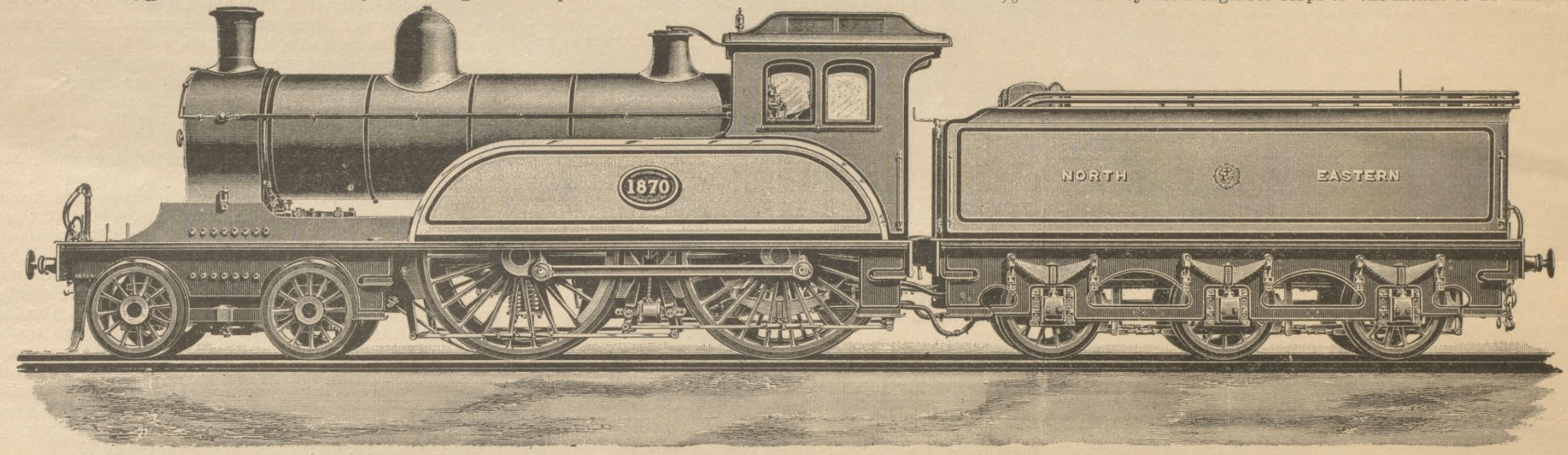
| | |
|---|---|
| Diameter of wheel seat | 7½ in |
| Diameter of bearings | 6 in |
| Diameter at center | 5¾ in |
| Length of wheel seat | 7¼ in |
| Length of bearings | 9 in |
| Length between centers of bearings | 3 ft. 7 in |
| Diameter of crank pins | 3¾ in |
| Length of bearing | -4 1-16 in |
| Throw of outside crank | 12 in |

BOILER (STEEL).

| | |
|---|---|
| Center of boiler from rail | 8 ft. 2 in |
| Length of barrel | 11 ft. 6 in |
| Diameter of boiler outside | 4 ft. 4 in |
| Thickness of plates | 9-16 in |
| Thickness of smoke-box tube plate | ¾ in |

FIRE-BOX SHELL—(STEEL).

| | |
|---|---|
| Length outside | 7 ft |
| Breadth outside at bottom | 3 ft 11 in |
| Depth below center line of boiler at front end | 5 ft 8 in |
| Depth below center line of boiler at back end | 5 ft ½ in |
| Thickness of front plate, back plate, sides and top plate | ⅝ in |
| Distance of copper stays apart | 4 in |
| Diam. of copper stays | 1 in |




EXPRESS PASSENGER LOCOMOTIVE—NORTH EASTERN RAILWAY, ENGLAND.

INSIDE FIRE-BOX (COPPER).

| | |
|---|---|
| Length at the bottom inside | 6 ft 3½ in |
| Breadth at the bottom inside | 3 ft 2¾ in |
| From top of box to inside of shell | 1 ft 5 in |
| Depth of box inside at front | 6 ft 4½ in |
| Depth of box inside at back | 5 ft 9 in |

TUBES (BRASS).

| | |
|---|---|
| Number of tubes | 201 |
| Length of tubes between tube plates | 11 ft 10⅛ in |
| Diameter outside | 1¾ in |
| Diam. of exhaust pipe nozzle | 5 in |
| Hight of chimney from rail | 13 ft 1 in |
| Grate area | 21 sq ft |

WEIGHTS IN WORKING ORDER.

| | |
|---|---|
| On truck wheels | 32,800 lbs |
| On driving wheels | 68,800 lbs |
| Total | 101,600 lbs |

## RUSTLESS COATINGS FOR IRON AND STEEL.*

M. P. WOOD.

The reported case of the corrosion of the floor beams in the old New York Times building, occurring, as it were, almost under one's feet in the short interval of thirty-five years, and in the hereinafter reported case of one of six days appears to be an unanswerable argument of the dangers of using the oxide of iron in any form for the protection of metallic structures from corrosion.

This argument may be reinforced by the query: What is or what will be occurring to the metallic portions of the many skyscrapers that are in process of erection in our own and other cities at the present time, under great dissimilarity as regards temperature, humidity, and other climatic conditions, but of one characteristic sameness, viz: being sealed in solid masonry or other coverings beyond the ken of inspection?

Inspection of these buildings now in progress, as well as those lately erected, reveals possibly a slight improvement in general over the conditions apparent two years ago; but the improvement is a hollow mockery, and will bear fruit for repentance ere many years have passed. These structures, though more carefully painted than those erected before with more and heavier coatings of some kind of stuff called paint, do not appear in a single case to have received any attention or consideration as to the condition of the metallic surfaces before applying the protective coating beyond a possible sweep with a dirty broom to get rid of the rough dirt from the workshop yard, and a possible wipe with a piece of old sacking to remove the grease due to machining processes. Anything like a washing down of the parts with soda ash or lye water to remove the grease and then pickling with weak acid to remove the mill scale, and a subsequent washing with lime water to neutralize the acid bath, warming the work before painting it, and care to apply the paint only on clear, bright days, when no sweating can occur, or applying the paint in warm paint rooms. It is safe to say that not in a single case out of the many skeleton structures of our modern sky scrapers can this be found to have been the procedure. Not only this, but in the minor parts of the structure, where the light grillage and ornamental partitions should at least claim these precautionary measures to be used, and where the question of weight and complexity of parts could not arise to cause a decision on the side of Cheap John methods.

It is an indispensable condition, in applying paint for the protection of metallic surfaces that the surface must not only be first prepared by cleaning it to receive the paint, but the manner and time that the coating is applied are strong factors towards getting a favorable result. A poor paint properly applied to a properly prepared surface will in general give a better and more lasting result than a good paint improperly applied to an improperly prepared surface.

The time is approaching when the new suspension bridges between New York City and Brooklyn—the North River bridge and the East River cantilever bridge, three of the most costly and important metallic structures of the many in the world—will require the most careful consideration by their engineer corps of the means to be taken to properly protect them from corrosion, as, aside from th comparatively unimportant quantity of the masonry used in their construction, the thousands of tons of steel that are embodied in them, divided and subdivided into thousands of separate parts, some accessible for examination as to their state at all times, but more that are so covered in when assembled as to utterly preclude any effective examination or the adoption of any protective methods other than those given at the time of their erection in place. The greater portion of the separate parts, large and small, that compose the whole structure will be comparatively unprotected during the greater part of the long years that they will be under construction, and subject to mechanical injury of whatever coating may be spread over them at the workshop, and also to those due to the varying changes in temperature and climatic conditions, aggravated by the presence of sea-air, to which inland structures of the same class of design would not be subjected, and whose complete failure from any cause would not be so disastrous as the partial failure of these.

The wires in the suspension cables of these structures (after having been freed from the mill-scale of manufacture and drawing to wire) will no doubt be protected by some system of coating with zinc, tin, or nickel to properly cover in the screwed couplings used to join the separate wires, notwithstanding the fact that the electric welding of the wires would give a stronger connection at possibly the same expense. That screwed or twisted connections have always been used for this purpose may possibly prove too great a precedent to ignore. But why the persistent use of coating such wires with either boiled or raw linseed oil instead of a reliable carbon or plumbago paint it is hard to conjecture. Linseed oil free from pigment, applied to any metallic surface, absorbs moisture freely as a sponge swells up, loosens its bond on the metal, and rarely if ever renews its bond when dried out. A properly prepared paint could be as readily applied as the oil, would take no longer to dry, and would resist friction and moisture greatly in excess of an oil coating, and be a proper foundation to receive the final protective coating ere the cables were finished or covered in.

As stated in previous papers read before this society, the corrosive agent is found in the oxide of iron pigment as usually prepared for the market, and claiming great superiority as to quality by reason of its bright attractive color and purity over other forms of oxide pigments ground from hematite ores, whose dirty brown purplish color indicates the presence of more or less clay and earthy matters, wholly unreliable as a pigment even when mixed with good linseed oil, and whose varying qualities are readily detected in the separate consignments from the same manufacturer or compared with each other. Of the samples from the many concerns turning out this Cheap John material, none are good, all are bad and comparatively useless for the protection of metal, however admirably adapted by virtue of their cheapness to wooden

*From a paper read before the American Society of Mechanical Engineers.

tructures, and are a poor investment for them if the merits of a better paint is considered.

How much damage is done to the internal parts of a marine vessel by the use of iron oxide paints with which those portions below water mark in the holds are usually coated it is hard to realize. Bilge water is a very corrosive fluid, composed as it is of sea water mixed with the leakage from fluid cargoes soured by the heat of the hold, the sulphur water from the furnace, ashes and pyrites in the coal bunkers, mill scale and paint oxides of copper and and iron thrown down in the course of repairs to boilers and hull and seldom if ever removed, continually agitated and washed over the exposed metallic surfaces, and aided by the presence of carbonic acid generated from the conglomerate mass in the confined air of the hold. It is scarcely to be wondered at that the vessel when in the dry dock for the too often extended yearly examination is found in such an advanced stage of corrosion that it is necessary to cut out and renew frames, bulkheads, and other parts so corroded as to endanger the safety of the ship in seaway. The engineer in charge in the due performance of his duties will attend to the repairs, but the ship owner who pays the bill when approached with the question, "What shall we coat her with to prevent this occurring again?" too often cannot see his way out of the dilemma, and says, "Give her the old stuff and let her go."

In the discussion following the presentation of the second paper on "Rustless Coatings," read before this society (Transactions A. S. M. E., vol. xvi.) Mr. F. H. Boyer cited the case of 1,800 ft. of twelve inch cast iron pipe, laid two and one-half years and used to pump sea water, that had changed in its entire length to plumbago, and could be readily cut with a knife, and would have to be renewed as a whole. Possibly the presence near the inlet of the pipe of some acid manufacture or waste pipe from it, or some sunken cargo of iron oxide may have contributed to this decay. Pure sea water is strongly corrosive, but not alike in its effect in all parts of the world; it is, however, stronger in its corrosive effect when mixed with sewage water, and this may have been one factor in the case. Mr. Boyer will confer a favor upon the engineering fraternity if he will give the results of his later examinations as to this case. Such records are of extreme value.

## MODERN IRON WORK APPLIANCES.

### VIII.—THE "BULLDOZER."

The word "bulldozer" has become very familiar in and about blacksmith shops, but it is not generally understood what the term means, and in many cases it is used erroneously. The word "bulldozer" is the trademark of one manufacturing company for its own machine, and a Bulldozer therefore applies to a certain machine which is manufactured by that company, and while the same pattern and general designs have been followed by other concerns, this title belongs to Williams, White & Company, of Moline, Ill., by whom the word was first used in its present meaning as applied to machinery, and where, if we are correctly informed, the design of machine shown in illustration, Fig. 27, originated.

This illustration shows what is known as No. 6 bulldozer, which is a massive machine and somewhat larger than those which are in general use. The length of this machine over all is 12 ft., and its width over all is 6 ft. 3 in.; and the face of the cross-head is 63 x 11½ in. The movement of the cross-head is 20 in.; the space for the dies, 38 in.; and the weight complete is 23,000 lbs. This machine is particularly recommended for car work in preference to any of the other six sizes manufactured by the company. The weight of the different sizes is as follows:

The machine known as No. 1 weighs 3,800 lbs.; No. 2 weighs 5,900 lbs.; No. 3, 7,800 lbs.; No. 4, 12,000 lbs.; No. 5, 18,000 lbs.; No. 6, 23,000 lbs., and No. 7, 45,000 lbs. The No. 7 machine, as will be noted by the weight, is a heavy affair, having an independent steam engine attached, and is used only for special work where a tremendous power is required.

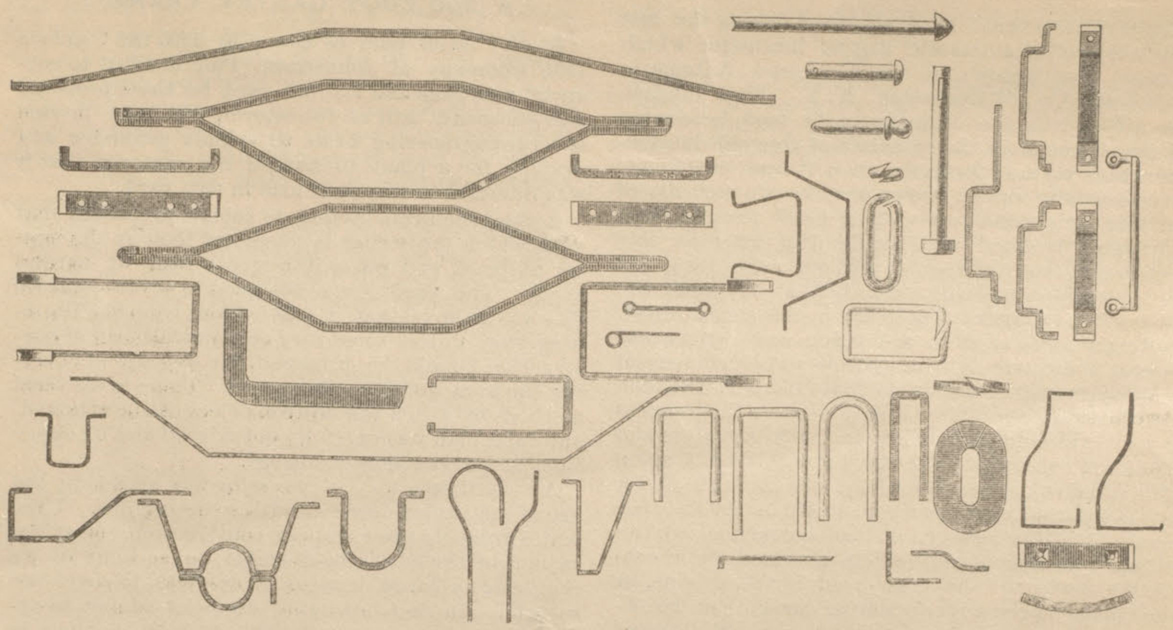


FIG. 28.—CAR IRONS FORGED ON THE BULLDOZER.

The bulldozer is so thoroughly familiar to the majority of our readers that a description of its operation seems altogether unnecessary. It might not, however, be generally known that these machines are now being built to be operated by steam or air and for some classes of work, one of these types has advantages over the customary crank machine. With this style of machine, the character of the stroke is that of a blow instead of a squeeze, and it has the ability of giving several strokes in rapid succession. For welding this is much better than slower movement and in some work it is often an advantage to be able to set up a piece by a succession of quick blows. This design also has the advantage of doing away with the necessity of pulleys and countershafts, which in some smith shops necessitates the installation of an additional engine or a power plant and is therefore an item of considerable account.

The large variety of work which may be performed on a machine of this class is pretty well understood, and the illustration, Fig. 28, gives a good outline of the car forgings which are regularly manufactured in car building as well as railroad shops.

## LOCOMOTIVE CYLINDER LUBRICATION.

To the Editor of the Railway Review:

The writer has been very much interested in the article in the RAILWAY REVIEW of November 7, in regard to the experiments in locomotive lubrication made by Mr. Parker, of the St. Paul & Duluth Railroad, and is very glad that Mr. Parker has taken the step that he has in order to know just what is going on at the steam chest of a locomotive when the ordinary sight-feed lubricator is in operation.

The writer has had considerable experience in the lubrication of stationary engines with different makes of sight feed cups, and has often had serious questions in his mind as what was going on in the pipes that conveyed the oil from the sight feed lubricator to the valve chest of the locomotive, and has been in doubt as to how with the ordinary sight feed cup the lubrication was increased when the locomotive was runninng at a high speed and decreased when the locomotive was on an up grade and running comparatively slowly. He also appreciates the points made in the article on page 625 of the same issue.

I am moved to write this communication by the

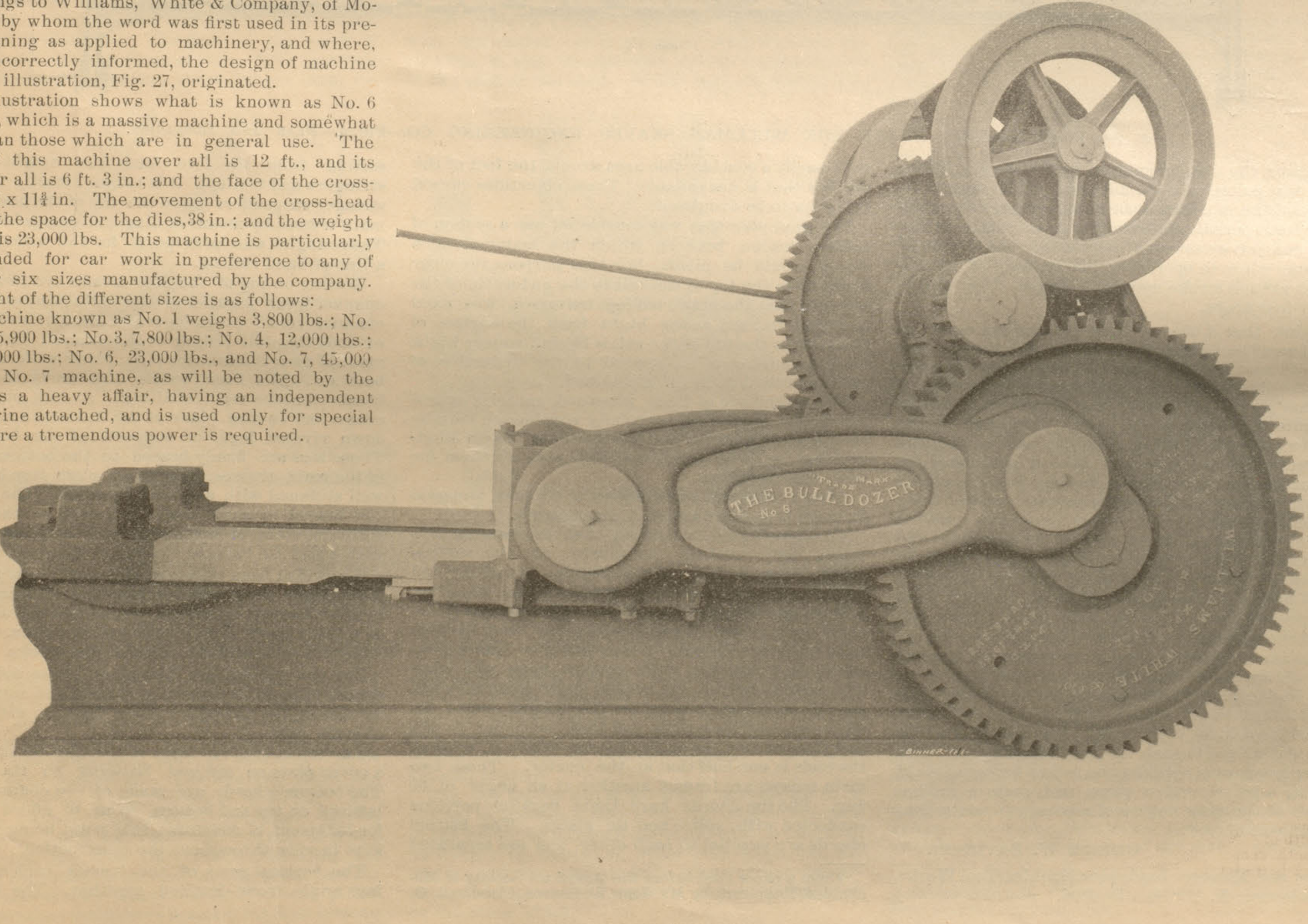



FIG. 27.—THE BULLDOZER.

results of tests that I have witnessed during the last few weeks of an automatic engine lubricator which is being manufactured by the Rochester Automatic Lubricator Co., of Rochester, N. Y. This lubricator differs from the ordinary sight feed lubricator in that it combines the principle of the old lubricator which we used formerly when it was customary to occasonally force a known or unknown quantity of oil into the steam chest with a hand pump. This lubricator is fitted with mechanism whereby this feed is constant and regular without submitting the oil to steam pressure or steam heat at all until the oil reaches the point of delivery in the steam chest. Quite a number of these are being used with great success in electric lighting stations and also in some of our large breweries, and in the State Industrial School, and it seems to the writer that this solves the problem of perfect locomotive lubrication, as far as valves and piston are concerned. This device consists of a pump with sufficient power to feed the oil through check valves against any pressure up to 450 or 500 lbs. per square inch if necessary, and as connected to the ordinary stationary engine it is actuated by a connection made to the cross-head of the engine, or some place where a reciprocating motion can be obtained. By means of compound levers, the throw regulating the distance moved by the levers which move the pump may be adjusted. The person in charge of the lubricator can at will change the number of feeds per minute from four to as many as desired, and also by means of regulating the stroke of the pump while in operation, the amount of oil delivered at each stroke may be changed from two to twenty-four drops.

I think that if one of these lubricators could be placed on a locomotive in charge of Mr. Parker that he would soon find the means of testing it, so that with the glass in the same position as before a small $\frac{3}{16}$ in. brass pipe would convey the oil so that it would drop into the center of the glass. Arranged in the manner suggested I think this cup would lubricate the locomotive the same as it does a stationary engine or an elevator cylinder, feeding just the proper number of drops of oil directly into the steam chest, without any admixture of water or steam, until it reaches that point. With such an arrangement the locomotive when running rapidly would have increased lubrication, and when working slowly it would have a decreased amount of oil fed, and when brought to a state of rest the feed would cease, but would start instantly when the locomotive starts.

This is a comparatively new invention, but it seems to an old mechanic who has had more or less to do with engineering for the past thirty-five years, that it is destined when given a trial to solve this question of locomotive lubrication. The writer has the same confidence in such an arrangement for lubricating locomotive cylinders as he has for successfully feeding a boiler with a pump and such a method permit of the same degree of accuracy in controlling the amount of feed.

George W. Davidson,

Treas. and Manager Rochester Machine Tool Works, Rochester, N. Y., Dec. 18, 1896.

## A 200 FOOT GANTRY CRANE.*

In the latter part of the year 1895 the Cambria Iron Company of Johnstown, Pa., decided to construct a storage and loading yard for their proposed new structural mill at Johnstown, Pa., and invited several engineering firms to submit estimates and designs for a plant to handle the material that it was intended to store and load in this yard.

Among the firms invited to submit proposals, that with which the writer is connected took up the matter at once, and gave it a great deal of careful study. The yard it was designed to cover—400x800 ft.—was so large that it was evident from the beginning that unless some very economical form of construction should be proposed, the expense of covering the area would be very great. There are several methods by which the desired object can be attained, and each plan was carefully considered and its objections and advantages compared.

A very simple way of covering any area is by the use of stationary derricks with swinging jibs. This, while probably the cheapest construction, is at the same time the most objectionable on account of its requiring a large number of derricks to cover the surface. In fact, swinging derricks cannot be arranged so as to cover the whole yard, as there is necessarily a considerable area around the foot of the derrick that is unavailable. These objections caused this plan to be dismissed.

The next plan that was considered was a system of surface tracks, between which the material to be stored would be piled. For this purpose the clear hight from the top of the rail to the underside of the stringer that the crane trolley traverses, was fixed at 20 ft. 0 in.: and as the hight from the surface of the yard to the top of the rail is 14½ in., a clear hight from the surface of the ground to the underside of the crane of 21 ft. 2¼ in. is obtained.

The magnitude of these proposed gantries caused the matter to be most carefully considered, both by the Cambria Iron Co. and the Wellman Seaver Engineering Co., who submitted this plan to them for their consideration.

After a thorough examination of the plan proposed by them they were awarded the contract.

The firm, before submitting their proposal for this crane, very carefully considered all the various forms of cranes, both of the regular traveling and the gantry types that are at present in use, and, after a thorough investigation of the different types, decided upon a form of construction that they believe to be entirely original. It consists of two main girders of the Pratt type, with vertical posts and diagonal tension braces, the bottom chord being straight and the top chord parallel to the bottom chord for about one-half its length, and then inclining to the end posts at such an angle that the depth of truss at the ends is one-half that at the center. These two main trusses are framed together at an angle of 60 deg. The top chords have their parallel portions connected with splice and tie plates. The bottom chords are parallel to each other, and are separated a distance of 20 ft. The main trusses are 18 ft. deep at center and 9 ft. deep at the ends.

This peculiar form of construction gives the arrangement of the main trusses the appearance of a steep-hipped roof, very long in proportion to its hight. A cross section at the center is that of an equilateral triangle, and the cross section at any point between the end posts and where the top chords join each other is that of a trapezoid.

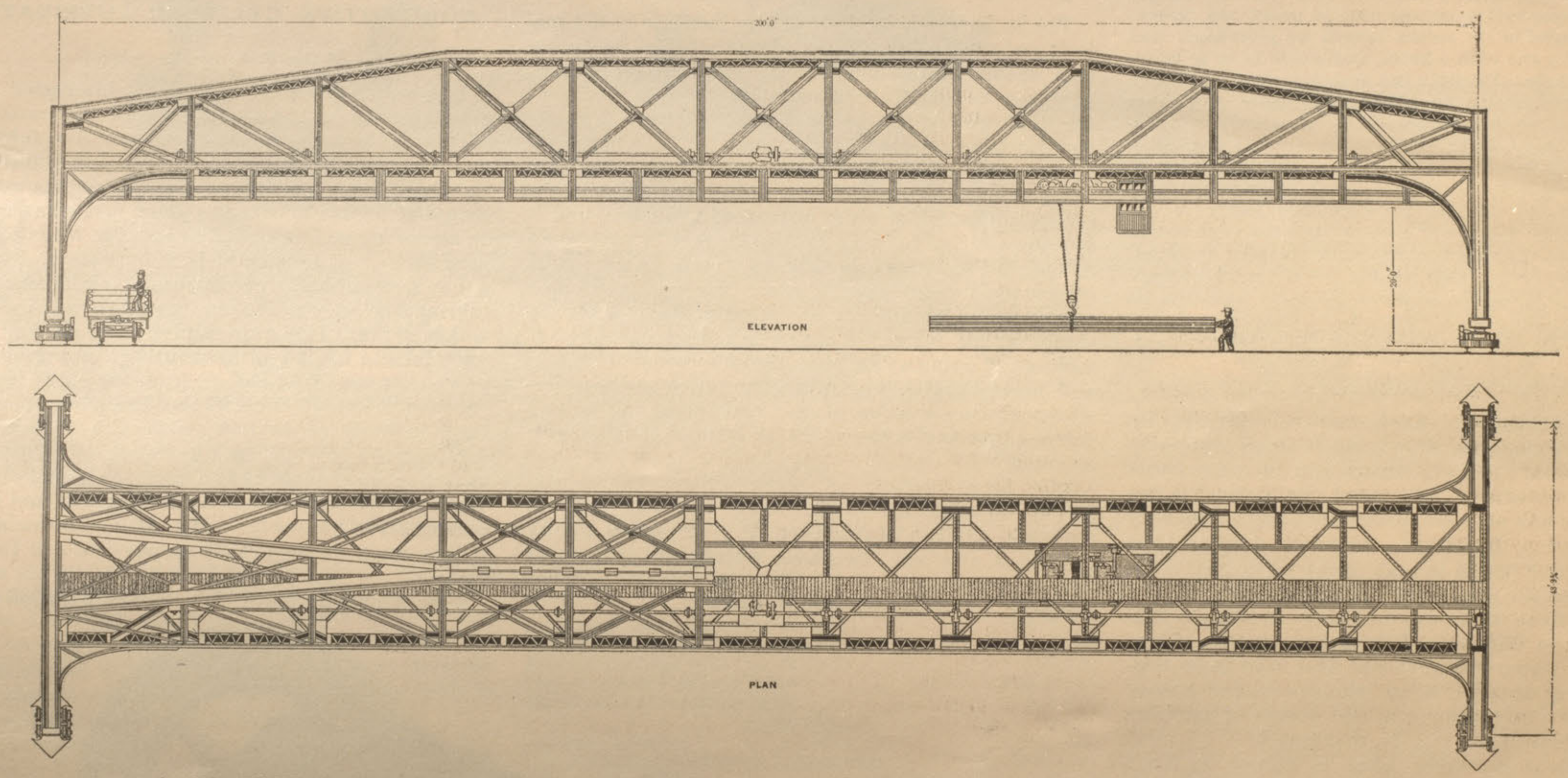
Suspended beneath the bracing that separates the bottom chords is a runway for the crane trolley to travel on. This runway consists of riveted I-beams, with T-rails secured to their upper flanges.

The stringers are very rigidly braced to the chords of the main trusses, not only at the panel points, where they are suspended, but also at the middle of each panel.

The horizontal bracing between the trusses consists of a series of floor beams, firmly riveted to the posts of the trusses, and forming the struts of the lateral system.

The diagonal members consist of angle irons riveted to wing plates secured to the trusses and floor beams, these wing plates being bent to conform to the angles of the floor system and the trusses.

To prevent any cross strains of the struts resulting from the live load (the weight of the stringers and trolley), it is taken directly from the stringer suspenders up to the top of the posts of the main trusses by means of diagonal suspender angles. These angles also form posts for the attachment of a line of hand railing.




A 200 FOOT GANTRY CRANE—THE WELLMAN SEAVER ENGINEERING CO.—Fig. 1.—Plan and Elevation.

Resting on top of the floor beams are two lines of channel irons parallel to the main trusses. These channel irons form stringers for the foot walk, which extends the full length of the crane. The walk is made of two thicknesses pine plank with tar paper between. The floor beams also carry the pillow blocks for the main shafting. At the ends of the crane, and in the plane of the trusses, are carried down riveted legs, or supports of the box form. These legs are firmly braced to the bottom chords of the main trusses, with large plate iron brackets, well stiffened with angle iron flanges. The legs are also braced to each other crosswise of the crane, with a system of horizontal and diagonal braces, with a stiff tie beam at the foot of the legs.

The width from center to center of the trucks supporting the crane is forty-three feet nine and three-quarter inches, forming a wheel base for the crane of a little more than one-fifth of the span, which is sufficient to square the crane on the tracks.

The end frames are formed of plates and angles, arranged so as to present a smooth end surface, the corners of the openings being filled in with curves of large radii.

The top chords are made of two channel irons with a cover plate on top and latticing on the bottom. The bottom chords are made of two channel irons, latticed on top and bottom, so as to afford no room for lodgment of moisture; this point being carefully kept in view throughout the construction.

The vertical posts of the trusses each consist of four angle irons latticed together. The diagonal

*From a paper read before the American Society of Mechanical Engineers by Mr. John W. Seaver, Cleveland, O.

members of the trusses are each formed of two angle irons riveted at their intersection. Particular care was paid to the connections of all members.

The loads and strains adopted for this crane were as follows: A live load for trolley equal to 20,000 lbs. To this was added, for impact, 25 per cent, or 5,000 lbs. The weight of the trolley was estimated at 23,000 lbs.—making a total of 48,000 lbs. distributed on four wheels, spaced about 9 ft. centers,

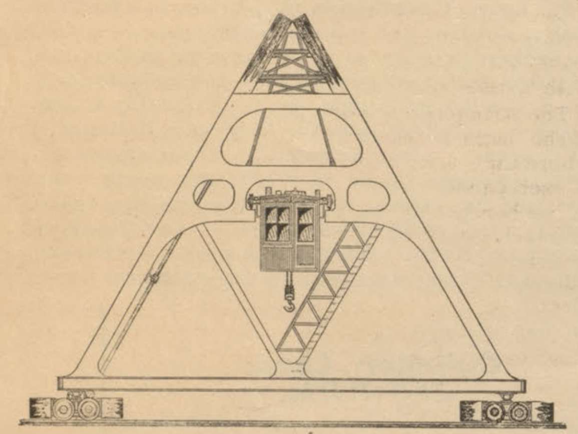


Fig 2.—END VIEW OF CRANE.

bringing a reaction upon each stringer support of 18,000 lbs.

To still further provide for any sudden application of a live load, it was assumed to be equal to 22,000 lbs. applied at any panel point of bottom chord of each truss.

This is largely in excess of any load that will come upon the crane; but it was considered advisable to use it, in view of the fact that the load might catch, thereby bringing a greatly increased weight upon the trolley.

The dead load, weight of trusses and floor, was assumed at 88,000 lbs. per truss, or 8,000 at every point of bottom chord of each truss.

In order to provide for a very large factor of safety in the bottom lateral system, a wind pressure of 20 lbs. per square foot was assumed, or a load of 5,000 lbs. at each panel point of bottom chord.

The minimum speeds of the various motions of the crane are as follows:

| | | |
|---|---|---|
| Traverse of main bridge | 200 ft. per min. | |
| " trolley | 400 | " |
| Hoist with full load | 20 | " |

The crane rests upon four trucks; each having four steel tired double flange wheels, twenty-four inches in diameter. The wheels are keyed to steel axles, five inches in diameter. The gage of the track is three feet six inches centers of rails. The journals are five inches in diameter, seven inches long, fitted with bronze bearings carried in cast steel oil boxes, with ample provision for lubrication. The wheels on one truck at each end are connected by means of a system of shafts and beveled gear wheels. The gear wheels are steel castings, and are of extra heavy design throughout. The shafting from one truck to the other is four inches in diameter. The couplings are all rigid flanged couplings, tightly keyed to the shafts, and fitted with turned bolts of a tight driving fit. The main shaft, extending the length of the crane, is carried in universal bearing pillow blocks of very heavy design. These pillow ocks are bolted to the cross beams of the floor systems with packing pieces between them and the beams, and are lined up perfectly true and level. The thickness of the packing pieces vary to suit the requirements of each individual pillow block.

The end bearings, where the main shaft is geared to the diagonal shafts that connect it to the track at each end, are carried by compound boxes, so that it is impossible for the main and angular shafts to get out of line.

Special care has been taken with all the bearings to provide ample facilities not only for the lubrication, but for the inspection and removal of any part. For most of the bearings compression grease cups have been supplied in addition to the usual lubricating holes and reservoirs.

The top of each truck carries a steel socket or cup, and in this socket is placed a hard steel ball six inches in diameter.

The bottom of the end supports are also provided with corresponding cupped sockets. The ball rests in a slightly elongated groove; the major diameter of the groove being crosswise to the center line of the truck, and the minor diameter being parallel to the track on which the truck rests. By means of this elongation of the groove the ball is allowed a slight motion at right angles to the center line of the track on which the truck travels, and this permits of the expansion and contraction of the main girders of the crane. It also allows the trucks upon which the crane travels to be slightly out of alignment, as the balls form universal joints between the trucks and the crane.

The arrangement of the gearing connecting the driving shafts to the trucks is such that the vibrations of the trucks around the centers of the balls do not disturb the alignment of the gearing to an appreciable amount, as the centers of the main driving spur wheels are on the same lines as the centers of the balls.

Directly in the center of the crane is placed a 50 h. p. electric motor, connected directly to the main shaft with one reduction of steel gearing.

The trolley which travels upon the suspended runway beneath the main chord is of the ordinary crane type, with the exception that the gearing throughout is of extra heavy design, and of either steel or bronze castings.

The winding drum is of cast iron, with right and left hand grooves for the chain, milled out of solid metal.

The traversing of the trolley upon the track and the hoisting is done by two 25 h. p. electric motors. All the motors are wound for 220 volts.

The operator's cage is attached to, and moves with, the trolley. It is provided with windows on all sides, so that the operator can have a clear view of any part of the yard. In the cage are placed the controllers which govern all the motions of the crane, and the necessary switches, cut-outs, etc. Over all the gearing is placed coverings or housings that are readily removable, the coverings being arranged to exclude all moisture of dust. The motors are also encased.

The end frames are so arranged that should it be desired to transfer a load from one side of the yard to the other, both cranes can be brought in line with each other by means of removable stops on the trucks, and the trolley from either crane run directly through the end supports and on to the track on the other crane.

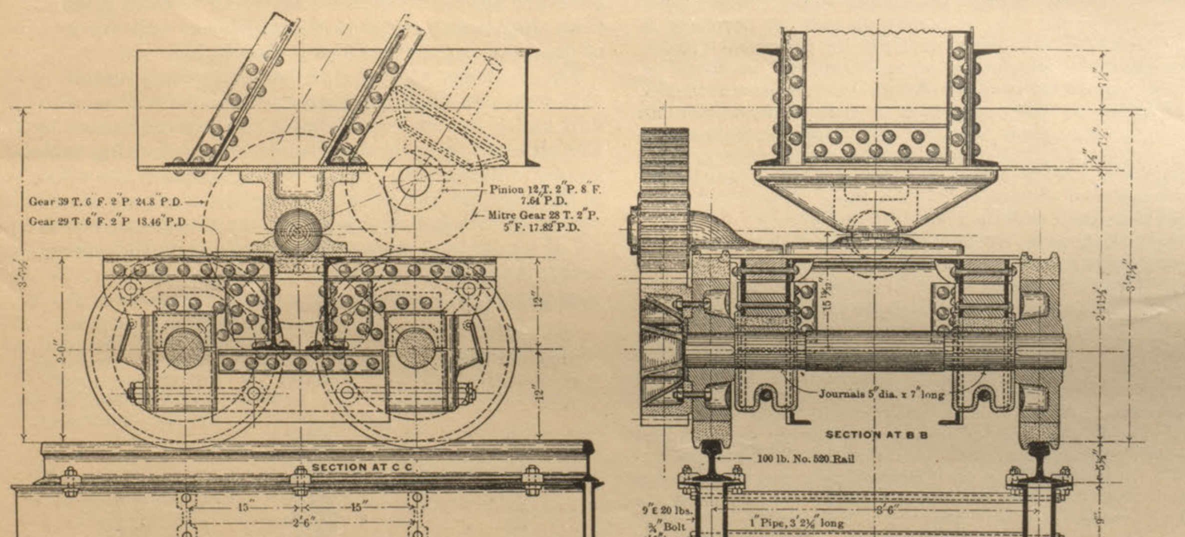



Fig. 2.—DETAIL VIEWS OF CARRIAGE SHOWING POWER ATTACHMENT.

## CAST STEEL IN LOCOMOTIVE CONSTRUCTION.*

One of the most interesting of the recent developments in locomotive construction has been the increasing use of cast steel, and before taking up in detail the advantages gained, it may be of value to mention the general reasons which have led to its wide substitution for cast and wrought iron. These reasons are, first, a desire to use as large a boiler as possible and the consequent lightening of the other parts as much as strength and durability will permit; second, the growing need for a stronger material than cast iron to withstand the increased strain of the large cylinders and high steam pressures used in modern locomotives; third, a desire to lighten reciprocating parts and thus reduce the effect of reciprocating counterbalances on the track; and, fourth, the substitution of cast steel for difficult and expensive forgings, which has been rendered possible and economical by the decrease in cost of steel castings and the improvement in quality.

The necessity of obtaining the maximum of power with the minimum of weight is the feature of locomotive designing which, perhaps, involves the greatest difficulty and requires the most careful consideration of any condition by which the locomotive designer is limited, and in this, locomotive designing differs radically from that of stationary engines.

It is true that there must be sufficient weight on the drivers in all cases for adhesion, but the maximum weight per wheel must not exceed the safe figure for the track upon which the locomotive is to run, and the total weight is frequently limited by the maximum load allowed on bridges. On the other hand, train service requirements are constantly becoming more severe, and large increases in cylinder boiler power are being made to meet the demands of high speeds and heavy trains.

For most passenger service, at least, the ability of the locomotive to do work is limited by its boiler capacity, and it is believed that the great demand upon the boilers of modern locomotives has been caused more by the increase in train speeds than by the increase of weights. With the maximum loads premitted on the rail it is often very difficult to use boilers large enough to do the work required, and it is necessary for the locomotive designer to lighten parts wherever possible in order to make up for the weight which must be put into the boiler. It is this necessity more than any other which has led to the increasing use of cast steel in locomotive construction.

The demand for a stronger material than cast iron, to withstand the strains of large cylinders and high steam pressures, has also been notable. The increase of strain due to high steam pressure is clearly shown from the fact that a 19 x 24 in. cylinder with 180 lbs. of steam has more power than a 21 x 24 in. with 145 lbs., the higher steam pressure corresponding in this case to an increase in power of 24 per cent. Increasing the size of parts to correspond with such increases of power is difficult in many cases, and with cast iron, unfortunately, increase of section does not mean an equal increase in strength.

The necessity of reducing the weight of reciprocating parts as much as possible does not need to be dwelt upon, and cast steel enters largely into the construction of the light reciprocating parts used in recent locomotives.

The use of cast steel as a substitute for cast iron generally increases the first cost of locomotives, the cost of the process and greater percentage of loss making the price per pound about three times that of cast iron, against which the saving of weight in most castings is only a small offset. The cost of machining is also considerably greater than for cast iron, as more finish is required to allow for unequal shrinkage, and the hardness and toughness of the metal requires the machines to be run at low speeds with light feeds thus increasing the cost of labor and lessening the output of the shop. In some cases, however, steel castings may be substituted for difficult forgings with a saving in first cost, but thus far this has proved true for locomotive use only in a few cases and with small forgings.

The substitution of cast steel for cast iron for driving wheel centers in American locomotives has been very recent. The first steel centers applied by the Schenectady Locomotive Works were put in service May 1, 1895. Since then 500 wheel centers have been used in passenger and freight service, including locomotives now under construction. Thus far the principal use for steel driving wheel centers has been for large passenger engines, but quite a number have been applied also to freight engines. For passenger locomotives the main advantages of steel are its decreased weight and greater strength. A photograph which I have shows cast iron and steel centers 62 in. diameter, designed for the same service, the saving in weight with the steel being about 610 lbs. per center, or a total saving for a four coupled engine of 2,440 lbs. I also have blue prints of different designs of steel driving wheel centers applied to passenger and freight engines. The strength and shock resisting power with the steel centers, even with a lighter weight, is undoubtedly very much greater than that of cast iron; in fact, with sound castings, free from shrinkage strains, it is difficult to see how a steel center can be broken except in a wreck. Great care, however, must be taken to avoid shrinkage strains. The rims are split in four places, which are carefully slotted and fitted tightly with planed cast iron plugs driven in so that the shrinkage of the tire will make the rim practically solid. Great care must also be taken in pouring the metal and while castings are cooling. The steel makers say, for instance, that the baked molds are so hard and unyielding that if the sand is not broken

*From a paper by Mr. J. E. Sague, mechanical engineer of the Schenectady Locomotive works, read before the New England Railroad Club.

away almost immediately after pouring, shrinkage flaws are almost certain to develop.

Cast steel driving centers for freight engines allow of a considerable decrease of weight, but the advantage of increased strength is probably of even greater importance, especially for the main wheels,as all six and eight coupled engines must have the main rod connected to the outside of the crank pin, thus exerting great leverage on the wheel center around the crank pin hub. When made of cast iron, these parts must be very heavy, and even when all possible has been done in design and material, cast iron main wheel centers are liable to give some trouble from cracking on heavy engines. It is believed that this might be entirely overcome with well constructed steel centers, and the lightening of the hub and rim which could be obtained would allow of increased counterbalance being put in the main wheel, as in small driver engines, with cast iron centers, the balance on main wheel must often be deficient.

For driving boxes cast steel has thus far had but limited use in spite of its great strength and the trouble experienced with broken cast iron boxes. The roads having the most experience with cast steel boxes, as far as the writer knows, are the Boston & Albany and New York, New Haven & Hartford. Probably one of the main objections to a more extended use of steel boxes has been the fear of bad results from wear between the box and wheel hub, and at the wearing surfaces of the shoes and wedges. Babbitt or bronze facing, however, seems to settle the question of hub wear satisfactorily. The large steel driving boxes fitted up for the New Haven engines before referred to had no special provision made for wear against the shoes and wedges, and we are assured that the results in service have been most satisfactory. Assuming that the wear can be made satisfactory, it is believed that steel boxes are destined to be quite generally used. Compared with cast iron they give strength and freedom from breakage, can be made to save considerable in weight, and the flanges can be reduced in thickness if desired,and thus allow the shoes and wedges to be widened to give more wearing surface. Steel boxes, also, being much stiffer than cast iron would have less tendency to spring when the brass is pressed in. As compared with solid bronze, steel boxes expand less with heat, and can therefore probably be run with a closer adjustment of wedges. The following letter received from Mr. John Henney, Jr., superintendent of motive power of the New York, New Haven & Hartford Railroad, gives very valuable information on the subject of the wear of steel boxes.:

"We have used steel driving boxes for two or three years before we had the last new engines built at your works. We also used them with babbitt facing, the same as those built at the Schenectady Locomotive Works, and find they work very satisfactorily.

"We have no trouble from using cast iron wedges in contact with the steel driving boxes. These wedges are kept as close as they were formerly with the cast iron boxes, and with better results.

"The babbitt facing on the boxes wear well. You can scarcely measure the difference after a year's wear and a year's wear on one of these engines frequently means 120,000 miles."

Cast steel is more widely used for cross-heads than for any other detail in locomotive construction. Cross-heads, of course, should be made as light as possible, consistent with ample strength and bearing surface, and the use of cast steel enables this to be done more effectually than with any other material. The photograph and drawing exhibited show the latest pattern of crosshead used by the Schenectady Locomotive Works on 20x24 in. locomotives carrying 190 lbs. of steam. The wings and wrist pins are cored hollow, decreasing the weight about 50 lbs. as compared with a solid cross-head without any sacrifice of bearing surface or practical decrease of strength. The total weight of this cross-head, fitted with bronze gibs ready for service, is 157 lbs. The centers for the "H" or Pennsylvania Railroad, style of cross-head are also best made of cast steel, and it is believed that cast steel Laird cross-heads can be so designed that the objection to this type on the score of broken piston rods can be practically overcome, especially if the rods are made with enlarged cross-head fits.

Cast steel frames are as yet only matters of experiment, and it is too early to give a decided opinion regarding their advantages or otherwise, compared with the hammered iron. The probable advantages that suggest themselves are as follows: All welds being avoided, the risk of breakage due to poor work is reduced, especially as the material in them is stronger and tougher than wrought iron. The Schenectady Locomotive Works, however, has long made it a practice to take three heats on each frame weld, and it is believed that this makes it almost certain that the frames are as strong at the weld as in any other part. Steel frames would admit of greater latitude of design than those of iron, as iron frames must be constructed with a view to easy forging and welding, and it seems probable that steel frames, if largely used, will lead to important modifications in design. It is possible, for instance, that the bars might be made of "T" or "I" section, thus reducing weight without sacrificing strength. The weakest parts of wrought iron frames, aside from possible defective welding, are through the bolt holes, and at these points the metal could be retained at full thickness and reduced elsewhere, thus keeping the net section nearly uniform. An objection to the use of cast steel which naturally occurs to one is the difficulty of repairing breakages. Cast steel in small sections can be successfully welded, but probably in larger sections the difficulty of securing a good weld will be much greater than with iron.

Dome rings made of cast steel have been largely used by the Schenectady Locomotive Works, and make a very successful job. In this case, however, it is being superseded by hydraulic flanged steel, which is believed to be the best material for the purpose. The use of steel in expansion pads and knees, foot plates, guide yoke and bumper knees, frame filling pieces, and similar locomotive details, is constantly extending. The main object, as before mentioned, is to save weight for the purpose of allowing increase in the size of the boiler. In all these cases, of course, very considerable gain of strength is secured, which will result, no doubt, in decreased trouble from breakage, and the use of cast steel will probably extend to a great many other details than those mentioned. In English practice cast steel is used to a considerably greater extent than with us. Mr. Hughes' book on the construction of the modern locomotive speaks of forty parts being made, among others, mud rings, guide yokes for inside connected engines, and crown bars. Even cast crank axles have been used to a very limited extent.

The more general introduction of cast steel is delayed by its high cost, the increased expense of machining, and the uncertainty of securing sound castings and prompt shipments. This often leads to unexpected delays in completing contracts for locomotives for which cast steel is largely specified, and causes expensive and annoying delays in the builder's shops. Many of the disadvantages which we have noted, however,are incident to the rather sudden demand for this material in many recent designs of locomotives,and will no doubt be largely overcome as steel gets into more regular use, and the locomotive designer has reason to be thankful that in endeavoring to meet the severe requirements of modern train service,he can command the use of a material so well adapted to his needs.

## INDICATOR DIAGRAMS FROM LOCOMOTIVE SCHENECTADY.

By W. F. M. Goss.

Professor of Experimental Engineering, Purdue University

II.

EFFECT OF THE INDICATOR PIPE.

At a recent meeting of the Institute of Mechanical Engineers (England) Mr. John A. F. Aspinall, well known by his writings to railroad men everywhere, remarked that he "had heard it said that next to an anemometer nothing can lie like an indicator." Engineers frequently have experiences which seem to justify this remark, but the prevarications of the indicator are due, not so much to faults in the instrument as to the influence of an unfavorable environment.

The careful manner in which the indicators used upon the Purdue locomotive were connected with the engine, was described in the preceding article, but it soon appeared that the cards obtained from them did not possess the same characteristics with those obtained from indicators attached to engines on the road. The thought then suggested itself to the writer that these differences might be due to a difference in the length of steam connections between the indicator and the cylinder. To test the matter, two indicators were fitted to the same cylinder-end, as shown by Fig. 4. In this figure, C represents an indicator in a position usual at Purdue, and P a second indicator in a position ordinarily occupied by an indicator on the road, the latter being connected with the cylinder by a well-wrapped curved pipe, $3\frac{1}{2}$ ft. in length; C has since been referred to as the "cylinder indicator," and P as the "pipe indicator." Simultaneous observations taken by aid of these instruments, when corrected for errors of individual springs, gave records which could be compared to show the effect of the pipe. As the results of this work have already been considerably discussed by the technical press, it will be sufficient to say that a pipe produces an effect upon all the characteristics of the diagram—the events of the stroke, the degree of curvature of the expansion and compression lines, and the area of the card. The events are recorded later than they actually take place in the cylinder, changes of pressure appear from the diagram to be more gradual than they really occur in the cylinder, and the area of the card is greater than it should be.

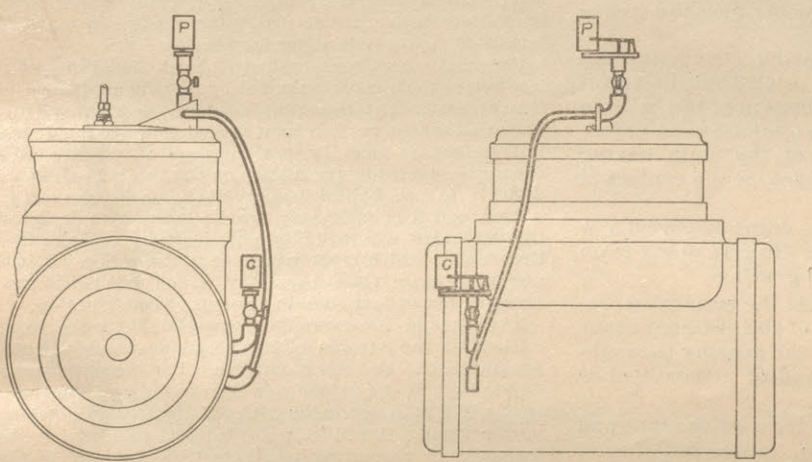



Fig. 4.—APPARATUS TO SHOW EFFECT OF PIPES.

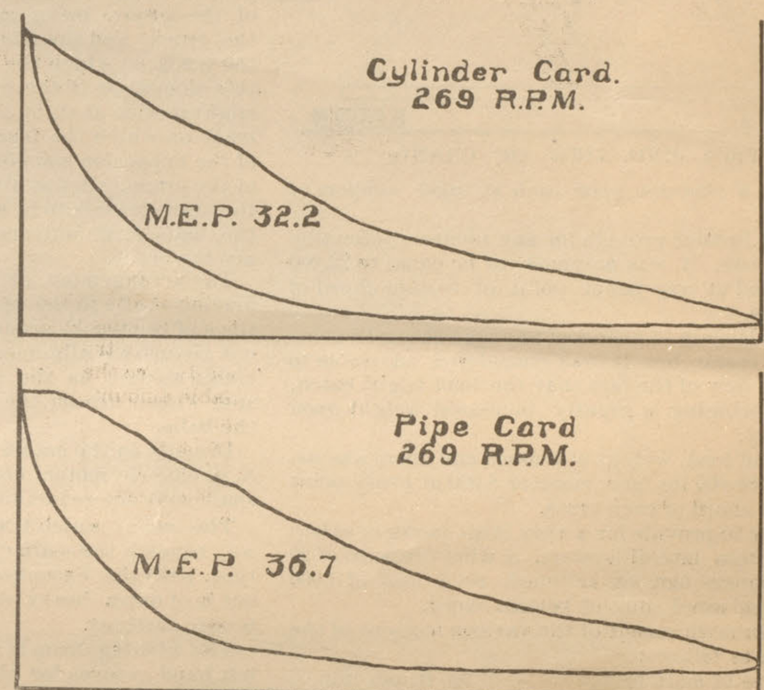



Fig. 5.—COMPARISON OF CYLINDER AND PIPE CARDS.

Fig. 5 shows at full size two diagrams taken in this way, one from the pipe and one from the cylinder, and the very considerable differences caused by the pipe can be seen at a glance. The following table presents numerical results which measure the effect of the pipe ($3\frac{1}{2}$ ft.) when the engine was run at different speeds and with a wide-open throttle and a cut-off of six inches, under the conditions of the experiments described:

ERRORS IN M. E. P. GIVEN BY PIPE INDICATOR SHOWN BY FIG. 4

| Miles per Hour. | Revolutions per minute. | Excess of power shown by pipe indicator as compared with that shown by Cylinder Indicator, in per cent. |
|---|---|---|
| 25 | 134.5 | 1.5 |
| 30 | 161.5 | 2.1 |
| 35 | 188.4 | 2.9 |
| 40 | 215.3 | 4.9 |
| 45 | 242.2 | 8.4 |
| 50 | 269.1 | 14.0 |
| 55 | 296.0 | 17.2 |

The significance of these results led to a much more careful study of the effects upon the indicator diagram produced by a long pipe-connection, and the conclusions have recently been presented in a paper before the American Society of Mechanical Engineers.* The latter work shows conclusively that while the effects produced by the pipe are pronounced, they are modified by so many different conditions that their precise character cannot be safely predicted. Even if it were possible to construct an expression for reducing a distorted pipe-diagram to a form which would correctly represent the relation of pressure and volume within the cylinder, the number of its terms would be so great that the expression would have little practical value.

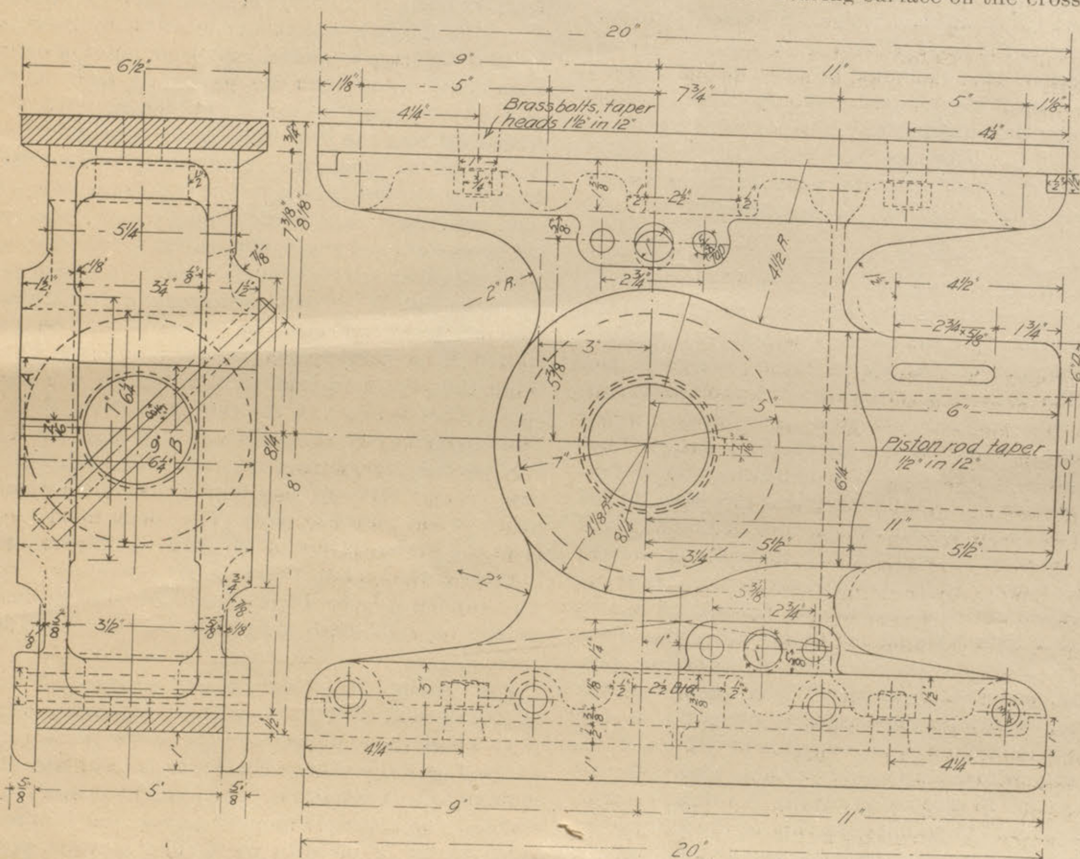
It is evident from these considerations that the indicator work obtained from the Purdue locomotive far exceeds in accuracy the best which has thus far

*"The Effect Upon the Diagrams of Long Pipe-Connections for Steam-Engine Indicators," Proceedings A. S. M. E. May, 1896.

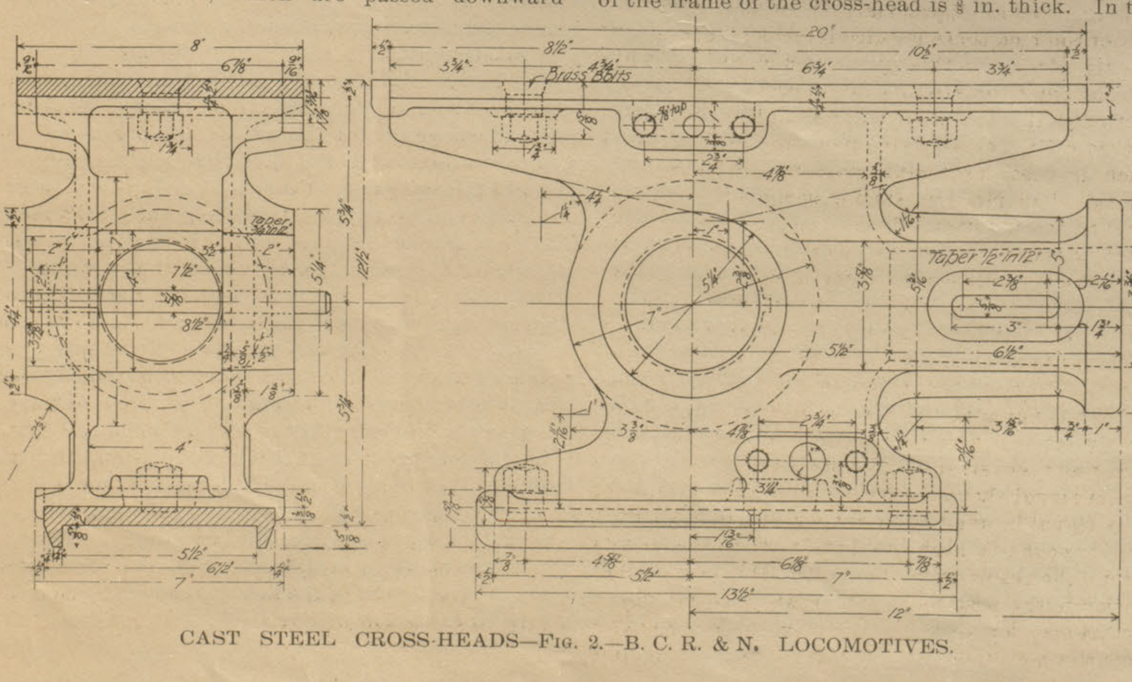
been produced on the road, but for this very reason the results should not be used in direct comparison with any similar results from the road.

## TWO RECENT DESIGNS OF CAST STEEL CROSS-HEADS.

In the RAILWAY REVIEW of December 12 of the current volume an illustrated description was presented of the new light cast steel cross-head recently designed by Mr. Thomas, superintendent of motive power of the Southern Railway, and which weighed 177 lbs. It will be remembered that in this case a nut was employed upon the end of the piston rod in order to secure it to the cross-head in place of the usual method of using a key. The two designs herewith illustrated differ from that of Mr. Thomas in that they employ the key and instead of having the wearing surfaces composed of tin, these are made with gibs, which are attached to the cross-head by brass bolts with taper heads. Fig. 1 shows the cross-head used upon the eight-wheel fast passenger locomotives recently furnished by the Brooks Locomotive Works to the Illinois Central Railroad, the locomotive having been illustrated and described in the RAILWAY REVIEW of December 5, 1896. This cross-head weighed in the rough before finishing 129½ lbs., which will be admitted to be extraordinarily light for such service. In this design the bearing surface upon the upper guide is flat with no wings or flanges inclosing the edges of this guide, the cross-head being maintained in line by the flanges upon a lower gib. It will be noticed that the upper bearing surface is 20 in. long by 8 in. in width, and that the lower bearing surface is 13½ in. long by 5½ in. in width. Both of the gibs in this design are secured by taper-headed brass bolts, which are passed downward through the bearing surface of the gib and through the shell of the cross-head, and to assist in resisting shearing stresses on the bolts which might be caused by the sticking of the gibs upon the guides, the gibs are lipped over the ends of the cross-head. This cross-head is fitted with two oil cups, one for the lower guide and the other for the cross-head pin. It will be noticed that the material of this cross-head is very thin except at the boss for the pin and for the piston rod fit. Material at the thinnest point is but ½ in. thick, which is the portion forming the backing for the gibs. Fig. 2 shows another cross-head by the Brooks Locomotive Works which was fitted to the locomotives recently furnished to the Burlington, Cedar Rapids & Northern Railroad the locomotives having been illustrated in the RAILWAY REVIEW of December 19, 1896. This design is considerably heavier than that of Fig. 1, and the weight of this in the rough was 201 lbs. It will be noted that the same style of guides were used in both cases as regards the form of the bearing surface on the cross-head, the lower bearing surface only being provided with lips inclosing the guide. In this design, instead of forming the lips in the gib itself, two strips are provided which are bolted to the cross-head and project downward 1 in. below the gib and prevent lateral motion of the cross-head. These strips are secured by means of four ⅝ in. bolts, and the gibs are held in position by two taper brass bolts and also by being lipped over the end of the cross-head. The hight and also the thickness of the material in this design exceeds that of the Illinois Central locomotives. In the former design the distance between the guides is but 12½ in. as contrasted with 60½ in. in the design shown in Fig. 2. The thickness of the casting in Fig. 2 is ⅝ in. as a minimum, and a major proportion of the frame of the cross-head is ⅝ in. thick. In this design both of the wearing surfaces are of the same length, 20 in., and the width of the upper gib is 6½ in. and the width of the lower one 5 in.




CAST STEEL CROSS-HEADS—FIG. 1.—ILLINOIS CENTRAL LOCOMOTIVES.




CAST STEEL CROSS-HEADS—FIG. 2.—B. C. R. & N. LOCOMOTIVES.

## THE RAILWAY SYSTEM OF THE ISLAND OF JAVA.

By A. SNETHLAGE.

The first concession for a railway in the island of Java was granted in 1862 for a line from Semarang to Djokja, which was soon followed by another for a line from Batavia to Buitenzorg. A company called the Dutch Indian Railway was founded with the object of constructing and working these lines, which were opened in 1873. So little confidence was shown in the success of the lines that the government of the Dutch Indies was obliged to guarantee interest of 4½ per cent during the construction. The government was soon convinced that private enterprise would not suffice for the construction of a well-designed system of railways, and decided therefore to construct a system itself. At the end of 1894 the state railways had a length of 677 miles, representing a capital of £7,440,000, or £10,846 per mile, which yielded a net profit of 4.70 per cent.

Although several concessions were granted between 1873 and 1893, two lines only, 50 miles in length, were constructed as well as two steam tramways, 170 miles in length. The regulation of 1893 for the construction and working of steam tramways, giving to companies greater liberty, led to the promotion of several "economical" lines under the name of steam tramways, which are constructed so that the rolling stock of the state railways can circulate upon them. These economical railways, of which 201 miles are in course of construction, will cost £4,466 per mile, including the rolling stock. The type of rail adopted is that used on the state railways, weighing 52 lbs. per yard, and having a length of 33.46 ft. The gradients are not steeper than 1 in 200, and the lowest radius for curves is 7½ chains. The locomotives are six-wheel coupled and weigh 21 tons in service. The regulation allows a train length of 131 yards (corresponding to a weight of 200 tons), a speed of 15½ miles an hour along the roads and 25 miles an hour along the other portions. The line can be laid along the roads so long as there remains for vehicular traffic a width of from 14.76 ft. to 18 ft., according to the amount of traffic; the road bridges belonging to the government can also be used when their width is sufficient to have 8.20 ft. for vehicles and pedestrians.

At the end of 1894 the railways in Java had a total length of 1073 miles in working order, and about 370 miles were in course of construction. The total receipts in 1894 were £1,063,665, or £1,050 per mile, whilst the net receipts were £598,376, or 5.71 per cent of the capital cost.

On the main line from Batavia to Soerabaia gradients of 1 in 25 and curves of 7½ chains are met with, but in the eastern part of the island they are not generally greater than 1 in 200, and 25 chains respectively. The gage for the whole of the system is 3 ft. 6 in., with the exception of the Semerang-Djokja line and its branches, which are laid with a gage of 4 ft. 8½ in.; on a portion of the latter railway three rails are laid on the same sleepers to suit both gages. The steel rails weighing 52 lbs. per yard are laid on wooden sleepers, 6.56 ft. long by 8.66 in. by 4.72 in.

The maximum load for passenger trains on gradients of 1 in 25 is 84 tons (two locomotives), with a speed of 15½ miles an hour, and on gradients of 1 in 40, 160 tons (one locomotive) with a speed of 37 miles an hour. For mixed trains the maximum load on gradients of 1 in 200 is 324 tons (one locomotive) with a speed of 28 miles an hour.

Various types of carriages are used, and details are given of two six-wheeled and two four-wheeled composite carriages belonging to the State Railway and the Dutch-Indian Railway. The wagons of the different companies are more uniform because all have to travel over the steam tramways.

Various types of locomotives are used. The following table gives the principal dimensions of one of the lightest and one of the heaviest locomotives used on the state railways:

| | Three-Axled, Four-wheel-coupled Tank Engine. | Four-Axled Six-wheel-coupled compound Tank Engine. |
|---|---|---|
| Weight, empty | 11.61 tons | 24.80 tons |
| Interior diameter of boiler | 2.77 ft. | 3.77 ft. |
| Length of boiler | 6.85 ft. | 10.00 ft. |
| Number of tubes | 82 | 157 |
| Fire-box surface | 40.00 sq. ft. | 52.64 sq. ft. |
| Heating surface of tubes | 219.81 " | 599.14 " |
| Total heating surface | 259.81 " | 651.78 " |
| Diameter of cylinders | 11.02 in. | 14.96 "<br>22.83 " |
| Stroke of piston | 14.96 in. | 20.00 in. |
| Diameter of driving wheels | 3.86 ft. | 3.62 ft. |

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## CHICAGO, SATURDAY, DEC. 26, 1896.

THE drop of steel rails to $25 is a step in the right direction. It means a good deal to the railroads. Track will be laid at $25 that would not be laid at $28. If $24 had been named it would have been nearer right. There is too much margin between cost of slabs and price of rails. The effect is to curtail demand. The trouble is railroad builders have to pay in their prices for steel rails enough to allow dividends on several million dollars of idle steel rail mill capital. Free competition would knock prices close to $20. Here we are paying upwards of $5 a ton to people for doing nothing. This evil may reach collosal proportions and call for something more than protest in type. Large sales of rails were quickly made on the announcement of the concession. More business is in sight. Some corporations are pushing through negotiations for rail supplies for 1897; others will undoubtedly follow. No further drop is anticipated. In fact, the remote possibility of a rise is vaguely hinted at as a possible outcome of a fresh understanding among the billet manufacturers. When two rail companies can supply the requirements of the country, what will we do with sixteen, or rather what will sixteen do with us? The steel trade is quiet. The structural steel makers think they have fixed matters permanently satisfactory in their recent roundup, but large buying interests still believe circumstances will join hands with fate and rearrange prices on a more satisfactory and impartial basis. The Carnegie interest has made a ten strike as regards ore. It controls coke, and with ore under its control, a fleet of lake-vessels, and its own railroad from the lake dump to the furnace mouth, it is in a position to ask what the other fellows are going to do about it.

IN A short talk made recently by Edward Everett Hale to the students of the University of Chicago, the speaker drew a distinction between work and labor, workmen and laborers, that should be given the widest publicity. These terms, as commonly un-[illegible]d, are regarded as practically synonymous, [illegible]plied by the speaker in question, they are of course [illegible]y opposed to each other. As defined by Mr. Hale, the laborer is a drudge, one who simply applies his muscles to the work in hand without thought and care for any result save that which will provide for his necessities; while the workman is of those who while employing their hands, are also using their brains, hearts or consciences. He estimates that ninety per cent of the people employed upon the large landed estates of England are mere laborers, while of the corresponding class in the United States ninety per cent are workmen, the disparity in the conditions of the two classes showing the difference between drudges and thinkers. The application made by Mr. Hale, addressing as he was a body of college students, was that their mission as teachers and leaders in the world, was to make workmen out of laborers, but the thought has a broader application. In no class of service is this distinction more needed that in railway operation. Mere laborers in that field are of less value than in perhaps any other vocation in which manual labor is employed, a fact that has not been sufficiently appreciated by those in charge of such properties. The policy pursued by practically all railroad managers until within a few years, and which is still employed by a large number, is to make the work of their men as machinelike as possible, giving them no chance whatever to exercise their individuality or brains. The natural consequence has been to create a class of labor that works the fewest possible hours for the greatest possible pay without thought or care for the results accomplished. Fortunately, during the past few years, a wiser policy has obtained footing and some progress has been made in the establishment of a better basis. The less a laborer and the more a workmen can be made out of the individual, the more valuable will be his service to a road, and therefore anything, even to the payment of a higher salary (which is ordinarily the last resort) that will contribute to this end should be employed. Let it be understood that the mere laborer in the railroad service, even if his occupation is only shoving trucks or tamping ties, making way-bills or working at the bench, is of the least possible value both to himself and to the railroad, whereas, a workman in any of these positions cannot fail to be of profit to all concerned.

A CORRESPONDENT of a contemporary railway technical journal recently described an effort which is being made by a railway in Massachusetts to solve the problem of colored lights for night signals, and makes the following statement: "A prominent railroad in this state has put up a signal with a green light for 'all right' and a red one for 'danger,' but has followed the English idea of making the distant signal precisely like the home; and has disregarded the plain lessons of experience, both in England and in this country, by omitting to interlock the distant with the home." The correspondent then takes up the question of the advisability of the use of a stop signal as a distant signal and finally asks the question: "Which way is the art of signaling progressing, backward or forward?" In answering the question, editorially the excuse is offered that the case described must be an experiment which if intelligently followed up would probably lead to something better. In discussing a thing like this, it is difficult to get past the point referring to the absence of interlocking between the home and distant signals, which must be pronounced as criminal stupidity, or perhaps utter ignorance of the fundamental rules of the handling of trains, not to mention an entire disregard of the foundation of train signaling. It seems difficult to believe that a person in responsible charge of signals could be guilty of such a thing. Our contemporary remarks that, "If the superintendent desires to continue it (the use of the signal) in peace, he should thank his stars that he is in New England instead of old. A distant signal not interlocked would be held by the British Board of Trade sufficient reason for declaring a railroad not entitled to the government certificate authorizing it to run trains." This is stating the case altogether too mildly, and it would seem more appropriate to observe that the rules of common sense require interlocking between such signals or else the signals should not be. While it is laudable to attempt to improve the present practice with regard to colored lights, the trial of any radically new system upon any line of track which is used for trains must be vigorously condemned. The place for such experiments is on territory which is sufficiently removed from the tracks and from the sight of engine men as to prevent the experimental signals from being seen by them while running trains. The question as to whether progress is being made in signaling may be answered emphatically in the affirmative. And even "experiments" such as the one under consideration will contribute indirectly, but none the less positively, toward the improvement. If, as is presumed, this signal is on a main track, governing high speed trains, and if the distant signal should happen to be cleared while the home signal is standing at danger, and if an accident should occur to a high speed train from this combination, the result would unquestionably be to call attention to the practice in such a way as to prevent its recurrence for years if not for ever. Judging from the fact that such experiments are possible, which should not be, some progress should be made immediately, and it is to be hoped that no one will be killed in the accident.

## TENTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION.

The tenth annual report of the Interstate Commerce Commission, an abstract of which was published in our issue of last week, is not less interesting than have been those of previous years. Naturally a large proportion of the report is taken up with the consideration of some of the more important cases which have been decided by the courts during the current year, among which the "Import Rate" case is given a large place. It is evident that in the opinion of the commission there is an apparent need of further legislation when under an existing law articles can be taken from an interior point in Great Britain to Liverpool, from there by steamer across the Atlantic and thence by rail through Pittsburgh to Chicago at a total cost from point of origin to destination, less than the published tariff on the same article from Pittsburgh to Chicago. While it is believed that the protective tariff idea should not be allowed to enter into transportation rate questions, it is nevertheless manifest that there should be some regulation made which would make the long and short haul principle applicable to all through rates, whether domestic or foreign. It is true that no control can be directly exercised over foreign vessels, but American roads can be and should be prohibited from participating in a through rate which is less than their current tariff rates for the same haul. That is to say, if the rate from New York to Chicago on a given commodity is fifty cents per hundred pounds, the railroad should not be allowed to join in any through rate from a more distant point which is less than fifty cents. The commission recognizes the impossibility of supervising import rates in their entirety, but there is no necessary reason why, under proper legislation, domestic shippers cannot be sufficiently protected by some such provision.

The "Social Circle" case is also commented upon at considerable length. It will be remembered that in this case the application of the basing point system adopted by the southern roads was held by the commission to be a violation of the long and short haul clause. The principle point of defense was that roads lying wholly in one state could elect at what points through rates from outside the state should apply and what points could be excluded from participation in such through rates. The court held that so long as a company made its road part of a continuous line, and joined in through rates to any point on its line, it was not competent to exclude other points, thus practically sustaining the view of the commission as to the meaning of the word "line" in the law. Respecting the "Brown" case, involving the right to refuse to testify because of the liability of incrimination, the commission says: "This decision seems to have effectually removed the embarassments hitherto encountered in obtaining the testimony of unwilling witnesses in penal cases, and under it, and the ruling of the supreme court in the Brimson case, little difficulty is now experienced in securing the attendence and testimony of such witnesses."

It will be noticed by reference to the abstract published last week, that the commission has given some attention to the question of mileage paid by railroad companies for the use of private cars. It also calls attention to the fact that the rate of progress in the equipping of cars with safety appliances and particularly couplers, must be greatly increased if the law is to be complied with. It may not be out of place in this connection to suggest that a comparatively short time remains in which to supply the required equipment, and inasmuch as there is not only no certainty, but very great doubt that the commission will extend the time, it behooves roads who wish to participate in interstate commerce to make the greatest possible effort to comply with the law. It is of course probable that the commission will extend the limit in some individual cases where it can be shown that a compliance with the requirements was practically impossible, but in view of the apathy which was manifest in this connection for some time after the enactment of the law, it is not believed that a general extension will be made.